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ABSTRACT

This study compared the ways boys and girls in a museum-based school perceive the merits, relative value and epistemological meaning of a range of investigative activities. After completing a unit on evolution, 89 seventh grade and 16 eighth grade students were asked to rank order the activities according to preference and complete a Likert scale survey on how they liked each activity. A sample of 26 students were interviewed to determine how they interpreted a museum diorama. Interestingly, Likert scale results indicate a similarity in the types of activities preferred by boys and girls. Interview results indicate a similarity in observational skills among boys and girls, but an increased focus on exhibit aesthetics by girls. Rank order results show similarities in most favored activities but also indicate several differences that may be useful in designing "gender-equitable" science learning. The study supports the use of alternative locations, such as museums, to provide common ground science experiences that meet the needs of both boys and girls. (Author)

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An Analysis of Student Perceptions of Learning Activities in a Museum-based School

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Abstract

This study compared the ways boys and girls in a museum-based school perceive the merits, relative value and epistemological meanings of a range of investigative activities. After completing a unit on evolution, 89 seventh grade and 16 eighth grade students were asked to rank order the activities according to preference and complete a Likert scale survey on how they liked each activity. A sample of 26 students were interviewed to determine how they interpreted a museum diorama. Interestingly, Likert scale results indicate a similarity in the types of activities preferred by boys and girls. Interview results indicate a similarity in observational skills among boys and girls, but an increased focus on exhibit aesthetics by girls. Rank order results show similarities in most favored activities but also indicate several differences that may be useful in designing "gender-equitable" science learning. The study supports the use of alternative locations, such as museums, to provide common ground science experiences that meet the needs of both boys and girls.

Introduction

Science educators are becoming increasingly interested in informal or alternative forms of education (e.g., museums and other non-school settings), in part, to better serve a broad range of students whose needs may not be met in traditional educational settings. Some research has focused on assessing whether museums are effective in meeting the needs of learners among a broad range of clientele (e.g., Miles and Tout, 1991; Boisvert and Slez, 1995; Ramey-Gassert, 1996; Sandifer, 1997). Gender differences have been shown to be significantly related to both achievement in science and access to science learning (e.g., Mullis and Jenkins, 1988; Kahle and Meece, 1994) and research indicates a need for gender considerations in the design of museum exhibits (e.g., Diamond, 1994). However, museum settings may be effective in reducing gender bias in learning because they provide a relaxed social atmosphere, the exhibits are open to exploration, there are opportunities to express individual differences in a non-threatening environment, and a sense of personal fulfillment is possible due to the multimodal learning strategies that modern museums promote (e.g., Csikentmihalyi, 1987).

This study examined how 7th and 8th grade male and female students perceived the intrinsic interest, rank-ordered relative value, and epistemological content of experiences at a museum-based school in an urban setting. Our data show there are many similarities in the types of activities that both boys and girls prefer, as well as some significant differences that may provide some guidelines for the way science educators design and implement science curricula.

Methods

The study took place at the Science Museum School in New York City. This middle school is a New York City public school affiliated with the American Museum of Natural History (AMNH) which is located across the street from the school. The student population is drawn primarily from the Upper West Side of Manhattan and Harlem, and reflects the multicultural, multiracial, and mixed socioeconomic character of this urban environment. The school district allows students to apply for the middle school of their choice, so there is some selection for interest in science and the desire to be in a museum-based school by the students and their families. The science curriculum of the school is based primarily on Museum exhibits and collections, with object-based investigation being a critical part of most lessons. Students visit the Museum for structured lessons at least once a week, and are given unlimited access to the Museum on their own time.

After completing a unit on evolution, students were surveyed to determine their impressions of the activities they did during the unit. Each activity was rated individually by the students using a Likert scale, and the students were asked to judge the relative merits of each learning experience by rank ordering them. A non-parametric rank order correlation coefficient was used to compare the relative rankings of the boys and girls. Selected students were also interviewed in the Hall of Human Biology and Evolution at AMNH to examine how they explained the exhibit dioramas, and what aspects of the exhibits aroused their interest. Eighty-nine seventh graders were surveyed and 11 were interviewed. Additionally, 16 eighth graders were surveyed concerning evolution lessons that they had done while in the seventh grade. They were also interviewed in the Hall of Human Biology and Evolution. Mean Likert scale ratings and mean rank order data for boys and girls were compared. Transcripts of interviews were prepared and examined to determine gender differences in observations and epistemological explanations students made about the exhibits.

Interviews were conducted by allowing the students to select two of the four dioramas related to human evolution in the Hall of Human Biology and Evolution at AMNH. Black and white pictures of the exhibits were distributed, and the students were given a few minutes to mark the parts of the exhibit that they found interesting. A brief, tape recorded interview was used to elicit the reasons for their choices.

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Activities from the evolution unit fall into three categories. Some activities took place in the halls of the Museum and were organized by a specific exhibit, often utilizing a worksheet written by the school staff. Examples of this type of activity were the use of the Birds of the World exhibit, and the Hall of North American Mammals to observe anatomical adaptations (Activities B, Q, and P from the List of Activities, Appendix A). These activities are identified by the code AMNH in the list. The second category of activity took place in a Museum classroom using artifacts from the Museum's teaching collection. The use of mounted animals to observe anatomical adaptations (Activities A and S) and the observation of hominid skull casts (Activity K) fall into this category. The third category of activity includes all lab activities that were not dependent on resources unique to the Museum. Although some of these activities did take place in the teaching lab at the Museum, others were conducted in the public school classroom.

Results

Using mean scores from the Likert scales (a scale of 1 to 5, 1 being highest), student impressions of learning activities were compared for boys and girls (Tables 1 and 2). With the exception of two activities, there was a high degree of similarity in the mean scores for all activities rated by the seventh graders. Likewise, the eighth grade ratings showed similarities in all but one activity. Seventh grade girls rated an activity which used common hardware items to construct mock cladograms, a type of evolutionary family tree, (Activity C) higher (2.4) than boys (3.2) ($t = 2.72$, $p < 0.01$). Seventh grade boys rated the dissection of a Lamprey (Activity F) higher (2.4) than girls did (3.1) ($t = -2.29$, $p < 0.03$). Eighth grade girls rated an activity which involved researching and constructing a cladogram of human evolution higher (1.5) than boys did (3.7) ($t = 3.9$, $p < 0.01$).

The correlation for rank order data (Tables 3 and 4) was not statistically significant for either the seventh or eighth grade students ($r = 0.22$, and $r = -0.28$; $p > 0.05$) indicating no significant correlation of rank order preference between boys and girls. Therefore, there is evidence of gender differences in preferences of activities demonstrated these rankings. It was interesting to note that two activities which used prepared specimens for comparative anatomy study (Activities E and F) were ranked significantly higher by boys ($t = -2.82$, $t = -3.55$; $p < 0.01$ for both). Boys also ranked a bacterial transformation activity (Activity G) higher than girls did ($t = -2.55$, $p < 0.05$). Two activities, in which students organized information into cladograms (Activities C and I), were ranked higher by girls ($t = 2.45$, $p < 0.05$ for C; $t = 3.17$, $p < 0.01$ for I). On the whole, it appears that the girls preferred activities that involved more generalized, open-ended, and inclusive ways of approaching investigations and that the boys favored activities that involved elaborate procedures and scientific instrumentation.

Rank order data for eighth graders showed no significant differences among the pairs of scores in Table 4. However, the small sample size (n=16) may have reduced the power of the test. Many of the lettered pairs were closely ranked, with the exception of Activity W, which was given a mean ranking of 8.7 by the boys and 6.0 by the girls.

Interviews conducted while observing the human evolution dioramas showed a high degree of similarity in the ways that boys and girls observed the exhibits. The points of interest in the exhibit were consistent for both boys and girls, as were the types and numbers of observations. The most frequent response for both genders was to begin with an observation about a specific part of the exhibit followed by a brief conclusion about how that particular part related to the total theme or context of the exhibit (Table 5, 76 instances for boys, 79 for girls). The main difference in the girls' responses was that they made more aesthetic comments concerning the artwork in the diorama or mood that the exhibit created (28 by girls, 11 by boys). Boys responded to the exhibit with more unanswered questions (17) than the girls did (1).

Discussion

In general, the results of this study indicate that, in this alternative setting, there seems to be gender similarity in the ratings of the merits of the learning activities based on Likert scale results (Tables 1 and 2). The activities presented to the students were all inquiry-oriented, object-based lessons or "hands-on" activities, with a high percentage occurring in a Museum hall or teaching laboratory at the American Museum of Natural History. The activities were structured to encourage observation and conclusion making, skills that most of the students who were interviewed demonstrated in relation to Museum dioramas.

In the eighth grade sample, one learning activity did show a significant difference in preference between boys and girls. This activity (Activity X) was a three-week project that culminated in the construction of a cladogram representing human evolution. Girls, who gave it a mean Likert rating of 1.7 (1.0 = highly rated), preferred this activity. The mean for boys was 3.7. During the project, students collected information from the Hall of Human Biology and Evolution, examined skull casts of fossil hominids, and worked with art supplies to create a cladogram that was used in a presentation to classmates. This activity was the only one in the unit that took place over more than one class period, involved coordinated group activity in the creation of a large display, and was presented to classmates. Any of these variables may have contributed to the girls' high preference. However, it augments growing evidence that girls are more satisfied with learning experiences that are group-based, cooperative, and holistic (e.g., Tobias, 1990). Furthermore, the artistic component may reflect the girls' preferential interest in aesthetics as reported from interview data in this paper.

Seventh grade Likert ratings showed significant differences for only two activities. The girls showed a preference for an activity that involved the construction of a cladogram using common hardware items such as nails, screws, nuts, and bolts (Activity C). The mean ratings for the girls and boys were 2.4 and 3.2 respectively. The lab was very open-ended, with students creating their own evolutionary relationships between the hardware items as if they were fossils of previously living

things. Students worked in groups and were free to chose which "fossils" were more primitive and which were more modern. Students prepared a poster sized depiction of their cladogram which they defended to their classmates. Boys showed a preference for a Lamprey dissection (Activity F), giving it a mean rating of 2.4, while girls rated it 3.1. This activity involved a dissection protocol which facilitated the comparison of the lamprey with other animals.

Data from rank ordering also demonstrated several similarities between boys and girls. For seventh graders, the highest ranked activity was the same for both genders. Three activities were ranked significantly higher by boys. In addition to the Lamprey dissection (Activity F) previously mentioned in relation to Likert ratings, the boys ranked a comparative anatomy lesson using prepared specimens of crayfish, barnacles, amphioxus, and tunicates (Activity E), and a bacterial transformation lab (Activity G) higher than girls did. All of these activities involved complex manipulations and use of scientific equipment either to perform a dissection or to insert a plasmid into *E.coli* bacteria. These variables may have contributed to the preferential ranking by males. Girls ranked two activities higher than the boys did. One was the construction of the hardware cladogram (Activity C) mentioned above in relation to Likert ratings, and the other was a Museum hall activity in which horse evolution was examined using an exhibit in the Museum's Hall of Mammals and Their Extinct Relatives (Activity I). Both of these activities involved the creation of cladograms based on student observations and interpretations. One dealt with hypothetical living things and the other with actual fossils. In both cases the students were encouraged to come up with their own interpretation of the cladogram.

Eighth grade rank order data showed no significant differences. As mentioned above, this may be due in part to the small sample size (n = 16).

Interview data show a comparable trend in responses by boys and girls, with more similarities than differences (Table 5). When asked to comment on specific items in dioramas that interested them, both male and female students responded most frequently by following an observation about the exhibit with a brief conclusion relating its significance to the scene being depicted. This is not surprising, considering the fact that these students have spent many hours in the Museum using exhibits, and that many activities have stressed these skills. Two differences are interesting to note. First, the girls made more comments that the researchers categorized as aesthetic statements. These statements pertained to the quality of the artwork in the exhibit or the mood the diorama created. The second difference was that boys responded more frequently with the statement that they were interested in a particular question about the exhibit, but they did not attempt to answer it. There was no further evidence obtained about why this difference occurred.

Conclusion and Significance

This study points to consistent similarities in the types of activities preferred by boys and girls, though there is differentiation based on a greater interest by girls in extended cooperative learning tasks, aesthetic issues, and investigative inquiries that emphasize more broad and inclusive outcomes, and involve less discrete and instrument-based learning skills. In this alternative setting, there were considerable similarities in perceptions among boys and girls based on Likert scale and interview data. The specific differences in these data and in the rank ordering of activities point to a need for serious consideration of gender issues and preferences by science education curriculum designers. These findings suggest an approach that includes the emphasis on the more aesthetic aspects of science and scientific phenomena, and more opportunities for differential task selection in science learning for boys and girls.

The age group of the students in this study is a critical at-risk group for science education. It is during adolescence that a general decline in interest in science occurs among all students, but particularly among female students (e.g., Mullis and Jenkins, 1988). As educators, we must understand the strategies that students are using to deal with science content in order to help them better organize their experiences, become scientifically literate, and feel more included in the scientific process. This investigation suggests that the use of alternate sites, such as museums, may provide an environment in which a variety of learning styles can be addressed, and students can feel comfortable exploring science. This would provide greater opportunity for equity in science learning for all students.

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Table 1 Likert Scale Mean Scores **Table 2** Likert Scale Mean Scores

Seventh Grade Respondents (n=89) Eighth Grade Respondents (n=16)

Activity	Boys	Girls	Activity	Boys	Girls
A	2.4	2.7	O	3.0	3.0
B	3.0	2.6	P	3.2	3.5
C1	**3.2**	**2.4**	Q	2.5	2.5
D	3.1	3.3	R	1.2	2.0
E	2.5	3.1	S	2.7	2.3
F2	**2.4**	**3.1**	T	2.8	2.4
G	2.3	2.3	U	3.3	3.0
H	2.1	2.7	V	2.0	3.0
I	2.9	2.6	W	3.7	3.2
J	1.5	1.1	**X1**	**3.7**	**1.5**
K	2.6	2.2			
L	3.2	2.9			
M	3.0	2.8			
N	2.9	2.6			

Table 3 Rank Order Preferences **Table 4** Rank Order Preferences

Seventh Grade Respondents (n=89) Eighth Grade Respondents (n=16)

Rank Order	Boys	Girls	Rank Order	Boys	Girls
1	J (3.5)	J (1.8)	1	R (3.0)	V (3.9)
2	H (4.9)	**C3 (5.0)**	2	V (3.8)	R (4.0)
3	**G3 (5.0)**	K (5.5)	3	X (4.7	T (4.6)
4	**F1 (5.6)**	**I1 (5.6)**	4	O (4.8)	X (4.9)

5 **E1 (6.2)** H (6.7) 5 S (5.5) O (5.3)

6 K (6.7) A (7.0) 6 P (5.7) S (5.3)

7 A (6.9) **G3 (7.2)** 7 T (5.7) W(6.0)

8 **C3 (7.2)** B (7.5) 8 Q (5.8) Q (6.1)

9 M (7.4) M (8.2) 9 U (7.0) U (6.3)

10 D (7.6) D (8.4) 10 W (8.7) P (6.4)

11 **I1 (8.2)** L (8.4)

12 B (8.3) N (8.4)

13 L (8.6) **F1 (8.5)**

14 N (8.6) **E1 (9.1)**

Note: In the preceding tables, values in parenthesis are the mean ordinal rank position assigned to each category by the respondents. Comparisons of pairs of activities within the rank ordering, evaluated by t-tests, are made for the same activity in each column. For example: in Table 3, Activity G for boys is 5.0 and for girls is 7.2.

Bold faced items indicate statistical significance

1. $p < .01$

2. $p < .03$

3. $p < .05$

Table 5 Frequency of responses from interviews in the Hall of Human Biology and Evolution

Category of response	Number of responses by boys n=13	Number of responses by girls n=13
Aesthetic	11	28
Gender Comment	1	3
Observation	23	22
Observation with Conclusion	76	79
Personal Judgment	8	7
Personal Preference	3	0
Recollection	2	5
Question	17	1

Appendix A: List of Activities

Seventh Grade Activities

A. Observing anatomical adaptations of animals using mounted museum specimens.

B. Observing anatomical adaptations of mammals in the Hall of North American Mammals (AMNH) .

C. Construction of a cladogram using hardware items such as nails, screws, nuts, and bolts.

D. Introduction to cladograms in the Hall of Vertebrate Origins (AMNH).

E. Comparative anatomy of the crayfish, barnacle, amphioxus, and tunicate using preserved specimens.

F. Dissection of the Lamprey.

G. Bacterial transformation of E. coli for Ampicillin immunity.

H. Comparative anatomy of the dogfish and skate.

I. Observation of fossils demonstrating horse evolution in the Hall of Mammals and Their Extinct Relatives (AMNH)

J. Natural selection activity using colored paper and clear acetate to model prey adaptations.

K. Observation of hominid skull casts to investigate human evolution.

L. Comparison of humans to other animals in the Hall of Human Biology and Evolution (AMNH).

M. Investigation of human evolution in the Hall of Human Biology and Evolution (AMNH).

N. Comparison of various primates, including humans, in the Hall of Primates (AMNH).

Eighth Grade Activities

O. Gathering evidence for evolution in the Hall of Mammals and Their Extinct Relatives (AMNH).

P. Observing anatomical adaptations of birds in the Birds of the World exhibit (AMNH).

Q. Observing anatomical adaptations of mammals in the Hall of North American Mammals (AMNH).

R. Bacterial transformation of E. coli for Ampicillin immunity.

S. Observing anatomical adaptations of animals using mounted museum specimens.

T. Observations of adaptations and population changes in the Endangered Species exhibit (AMNH).

U. Construction of a cladogram using hardware items such as nails, screws, nuts, and bolts.

V. Natural selection activity using colored paper and clear acetate to model prey adaptations.

W. Observing population dynamics using Lima beans.

X. Researching and constructing a cladogram of human evolution.